TRANSLATION

(12)Japanese Laid-Open Patent Application
(11)Publication number : Hei11-109770
(43)Date of publication : April 23,1999
(51)Int.CI. G03G 15/16
F16C 13/00

---

(21)Application number : Hei09-268861
(22)Date of filing : October 1,1997
(71)Applicant : CANON INC
(72)Inventor : OGAMA Hiroko
HASEGAWA Hiroto
(74)Attorney : WAKABAYASHI Tadashi et al.

---

(54)[Title of the Invention]

Transfer Roller and Image Forming Apparatus Having Transfer Roller

(57)[Abstract]

[Object of the Invention]

To provide an image forming apparatus having a transfer roller capable of accomplishing the objective of preventing the phenomenon that a photosensitive drum is contaminated by the ingredients of a transfer roller, as well as the objective of stabilizing the image forming apparatus in recording medium conveyance

force, without being coated, across the surface of the solid transfer roller, with a material for forming a barrier layer for preventing the ingredients of the transfer roller from seeping out, or a mold releasing substance which is highly effective to prevent the adhesion of paper dust or the like.

[Solution]

To form a layer of solid rubber around a metallic core, and subject the solid rubber layer to the primary vulcanization process. Then, the solid rubber layer is subjected to the secondary vulcanization process. Then, the solid rubber layer is polished, and then, is subjected to a surface treatment such as irradiating with ultraviolet rays.

[Claims]

[Claim 1] A transfer roller characterized in that it is manufactured using the method in which the process of forming an elastic layer of solid rubber, around a metallic core, the process of vulcanizing the solid rubber (primary vulcanization process), the process of vulcanizing the solid rubber for the second time (secondary vulcanization process), the process of polishing the elastic layer, and the process of treating the surface of the elastic layer, are carried out in the listed order.

[Claim 2] A transfer roller according to Claim 1,

characterized in that the roughness index (Rz) of its surface is no more than 10 μm.

[Claim 3] A transfer roller according to Claim 1 or 2, characterized in that the condition for the second vulcanization process is such that the temperature is in the range of 120 - 200°C, and the duration is in the range of 30 - 120 minutes.

[Claim 4] A transfer roller according to one of Claims 1 - 3, characterized in that the process for treating the surface of the elastic layer is to treat the surface of the elastic layer with ultraviolet rays.

[Claim 5] A transfer roller according to one of Claims 1 - 4, characterized in that the elastic layer is formed of solid rubber, the hardness (ASKER-C scale) of which is no less than 40 degrees and no more than 80 degrees when it is under a load of 1 kg.

[Claim 6] An image forming apparatus comprising a transferring member of the contact type kept in contact with an image bearing member, said transferring member having an elastic layer and being rotatably shaped, and transferring means for transferring the toner image on the image bearing member onto recording medium, in the transfer nip formed between the image bearing member and transferring member of the contact type, while conveying the recording medium kept pinched in the transfer nip, characterized in that the transferring

member of the contact type is in accordance with one of Claims 1 - 5.

[Claim 7] An image forming apparatus according to Claim 6, characterized in that said transferring member of the contact type is rotationally driven at such a peripheral velocity that is different by +5 - 6 % from that of the image bearing member.

[Detailed Description of the Invention]

[0001]

[Industrially Applicable Field]

The present invention relates to an electrophotographic printer, an electrophotographic copying machine, an electrostatic recording apparatus, etc., in particular, an image forming apparatus which employs a roller-based transferring method. More specifically, it relates to the improvement of a transfer roller used for such an image forming apparatus as the above described one.

[0002]

[Prior Arts]

In the past, a majority of electrophotographic image forming apparatuses employed one of the transferring methods of the contact type, which are very small in the amount of ozone (which is deemed harmful) generated during the image transfer. Among these transferring methods of the contact type, a

roller-based transferring method which is superior has become the mainstream method.

[0003]

In the roller-based transferring method, a transfer nip is formed by pressing a transfer roller having an elastic rubber roller layer, upon a photosensitive drum as an image bearing member, and a toner image on the photosensitive drum is transferred onto recording medium, in the transfer nip, by the function of the transfer bias applied to the transfer roller while the recording medium is conveyed through the transfer nip.

[0004]

As the transfer roller, generally, an elastic sponge roller is used, which is made up of a metallic core formed of SUS, Fe, or the like, and an electrically conductive, spongy, and elastic layer formed around the metallic core. The electrical resistance of the elastic layer has been adjusted to a value in the range of 1×10^6 - 1×10^{10} Ω. The hardness of the elastic roller is in the range of 20 - 40 degrees (ASKER-C scale). Further, in recent years, market has begun to increasingly demand an image forming apparatus capable of printing an image on various recording media, and with the increase, an image forming apparatus employing a solid transfer roller, the elastic layer of which is formed of

electrically conductive solid rubber, which is superior in recording medium conveyance performance, has been developed.

[0005]

The elastic layer of a solid transfer roller is formed of solid rubber which is highly resilient. Therefore, a solid transfer roller is superior to a transfer roller in accordance with the prior art, that is, a transfer roller of the sponge type, in terms of the amount of grip it has on recording medium in the transfer nip, being therefore not likely to be easily affected by the back tension which occurs as recording medium is fed into the main assembly of an image forming apparatus, the conveyance resistance, that is, the friction which occurs between the recording medium conveyance path and recording medium as recording medium such as a postal card or a piece of cardboard is conveyed through the recording medium conveyance path. Thus, a solid transfer roller enjoys merit in that it can reliably convey recording medium. It is distinguishable in that when it is used with an image forming apparatus of the so-called excess velocity transfer roller type, that is, an image forming apparatus, the transfer roller of which is rotated faster than its photosensitive drum to convey recording medium fast than the peripheral velocity of the photosensitive drum so that the effect of causing

the recording medium to scrape the toner on the photosensitive drum away from the photosensitive drum is achieved to prevent the formation of an image having unintended white areas, it is smaller than a transfer roller of the sponge type, in the fluctuation in the recording medium conveyance speed, which is caused by the fluctuation in the print ratio.

[0006]

[Problems to Be Solved by the Invention]

However, an image forming apparatus, which employs a transfer roller in accordance with the prior art suffered from the following problems.

[0007]

(1) In the rubber of which the elastic layer of a transfer roller is formed, the residues of the initiator added to synthesize the base polymer, by-products generated when the base polymer was synthesized, low molecule components of the base polymer, vulcanizing agent and softening agent added when the rubber roller was molded, plasticiser, etc., are contained. Most of these substances are likely to react with the surface layer of a photosensitive drum. Thus, there is the following problem. If a transfer roller and a photosensitive drum are left pressed upon each other for a long time, these substances seep out of the transfer roller, and adhere to the photosensitive drum, reacting with the surface of the

photosensitive drum. As a result, the surface of the photosensitive drum is changed in properties.

[0008]

In particular, a solid transfer roller is higher in hardness, being therefore narrower in the transfer nip it forms, than a sponge transfer roller, the elastic layer of which is formed of spongy rubber. Therefore, a solid transfer roller is likely to be higher in the contact pressure (per unit area) against a photosensitive drum. Therefore, the low molecule components of the material rubber, vulcanizing agent, plasticizer, etc., which are in a solid transfer roller, are likely to seep out onto the surface of the transfer roller. Thus, a solid transfer roller is left pressed upon a photosensitive drum for a long time, the substances having seeped out of the solid transfer roller adhere to the surface of the photosensitive drum, resulting in the formation of a disturbed image. There is also the problem that the surface of a photosensitive drum reacts with these substances, changing in properties; in an extreme case, it is bleached. Therefore, the images formed thereafter will be all disturbed.

[0009]

There is also the following problem: A solid transfer roller is greater in the adhesiveness of its surface. Therefore, as recording paper is conveyed for

image transfer, paper dust, toner, etc., adheres to the surface of the solid transfer roller, contaminating the surface. The adhesion of these substances to the surface of a solid transfer roller changes the electric resistance of the surface. As a result, it becomes impossible for transfer current to continuously flow by a proper amount, resulting in the formation of an abnormal image.

[0010]

As the solution to the above described problems, it is possible to coat the surface of a transfer roller with such a substance that can form a barrier layer for preventing the ingredients of the transfer roller from seeping out onto its surface. However, this solution is problematic for the following reason: It renders a transfer roller multilayered. Further, not only does it add to the cost of the materials for a transfer roller, but also, it complicates the manufacturing process for a transfer roller, increasing thereby transfer roller cost.

[0011]

It is also possible to coat the surface of a transfer roller with such a substance that is excellent in mold releasing property so that even if paper dust lands on the surface of the transfer roller, it does not adhere to the surface. However, this

solution is also problematic for the following reasons. That is, a substance which is excellent in mold releasing property is generally expensive, and therefore, the usage of such a substance increases a transfer roller in cost.

[0012]

(2) In an image forming apparatus of the excess velocity transfer roller type, recording medium is conveyed while slipping between the photosensitive drum and transfer roller. Therefore, the recording medium conveyance speed is made to substantially change, by the changes in the external diameter of the transfer roller, changes in the surface properties of the transfer roller, changes in the conveyance resistance of the recording medium conveyance path, etc. Therefore, there has been the problem that the image forming apparatus is reduced in the ability to prevent the formation of an image suffering from unintended while areas (vacant areas), and/or the trailing end portion of an image misses the trailing end portion of recording medium. A solid transfer roller is higher in recording medium conveying force, and more stable in the recording medium conveyance speed in the transfer nip than a transfer roller of the sponge type. However, it still is prone to the changes in the recording medium conveyance speed in the transfer nip.

[0013]

For the purpose of reduce this changes in recording medium conveyance speed, it is effective to increase the transfer roller in the amount of force by which it grips recording medium in the transfer nip, by increasing the amount of pressure by which a transfer roller is kept pressed upon a photosensitive drum. However, a solid transfer roller is relatively hard. Therefore, as the amount of pressured applied to keep a transfer roller pressed upon a photosensitive is increased, the amount of pressure (per unit area) to which the transfer roller is subjected in the transfer nip substantially increases, increasing thereby the amount by which the ingredients of the transfer roller, which possibly contaminate the photosensitive drum, seep out of the transfer roller. Thus, it has been difficult to accomplish the objective of preventing a transfer roller from contaminating a photosensitive drum, while accomplishing the objective of keeping an image forming apparatus stable in the recording medium conveyance force.

[0014]

The objective of the present invention is to provide an image forming apparatus having a solid transfer roller, which can accomplish the objective of preventing the phenomenon that a photosensitive drum

is contaminated by the ingredients of a transfer roller, as well as the objective of stabilizing the image forming apparatus in recording medium conveyance force, without being coated, across the surface of the solid transfer roller, with a material for forming a barrier layer for preventing the ingredients of the transfer roller from seeping out, or a mold releasing substance which is highly effective to prevent the adhesion of paper dust or the like.

[0015]

[Means to Solve the problems]

According to the present invention, in order to solving the above described problem, by using the method in which the process of forming an elastic layer of solid rubber, around a metallic core, the process of vulcanizing the solid rubber (primary vulcanization process), the process of vulcanizing the solid rubber for the second time (secondary vulcanization process), the process of polishing the elastic layer, and the process of treating the surface of the elastic layer, are carried out in the listed order, it is possible to provide a transfer roller which can accomplish the objective of preventing the phenomenon that a photosensitive drum is contaminated by the ingredients of a transfer roller, as well as the objective of stabilizing the image forming apparatus in recording medium conveyance force,

without being coated, across the surface of the solid transfer roller, with a material for forming a barrier layer, or a highly effective mold releasing substance.

[0016]

[Embodiments]

According to the present invention, which relates to an image forming apparatus employing transferring means of a roller type, more specifically, transferring means employing an electrically conductive solid transfer roller, prevents the ingredients of the transfer roller from seeping out onto the surface of the transfer roller,

(1) By manufacturing a transfer roller with the use of a manufacturing method in which the precursor of a transfer roller is subjected to the secondary vulcanization process before it is polished; thereafter, the precursor is polished across the surface of its rubber portion to give the precursor a preset external diameter and a desired shape; and then, the surface of the rubber portion is subjected to a surface treatment, such as irradiating with ultraviolet rays, treating with ozone, or the like, the low molecule ingredients of rubber, which are present in the surface portion of the transfer roller, and the additives such as vulcanizing agents, etc., are purged by the secondary vulcanization process, and also, the surface portion of the elastic layer are

turned into a seepage prevention layer by the surface treatment, making it thereby possible to prevent the phenomenon that ingredients of the rubber portion of a transfer roller seep out onto the surface of the transfer roller.

[0017]

Further, by giving, after the polishing of the surface of the rubber portion of the transfer roller, the surface of the rubber portion of the transfer roller a surface treatment to smooth the surface of the transfer roller so that the surface becomes no more than 10 μm in roughness index Rz, the changes in the recording medium conveyance speed, which is attributable to the direction in which the surface is polished, the nonuniformity in the surface roughness, are prevented, and the adhesion of paper dust and/or toner to the roller surface is prevented, making it possible for the image forming apparatus to continuously yield satisfactory images for a long time.

[0018]

(2) By manufacturing a transfer roller with the use of a manufacturing method in which the precursor of a transfer roller is subjected to the secondary vulcanization process before it is polished; thereafter, the precursor is polished across the surface of its rubber portion to give the precursor a preset external diameter and a desired shape; and then,

the surface of the rubber portion is subjected to a surface treatment, such as irradiating with ultraviolet rays, treating with ozone, or the like, the low molecule ingredients of rubber, which are present in the surface portion of the transfer roller, and the additives such as vulcanizing agents, etc., are purged by the second vulcanization process, preventing thereby such substances in the transfer roller that possibly contaminate the photosensitive drum, from seeping out of the transfer roller, even under a large amount of transfer pressure, accomplishing thereby the objective of stabilizing the image forming apparatus in the recording medium conveyance in the transfer nip, as well as the objective of preventing the transfer roller from contaminating the photosensitive drum.

[0019]

Hereinafter, the present invention will be described in detail.

(1) Image Forming Apparatus

Figure 1 is a schematic sectional view of the image forming apparatus in accordance with the present invention. In Figure 1, designated by a referential symbol 1 is a photosensitive drum as an image bearing member, which is made up of a cylindrical substrate formed of aluminum, nickel, or the like, and a layer of a photosensitive substance, such as OPC, amorphous

silicon, or the like, formed on the substrate. The photosensitive drum 1 is rotationally driven by a driving means A at a preset peripheral velocity in the clockwise direction *a* indicated by an arrow mark.

[0020]

Designated by a referential symbol 2 is a charging means for uniformly charging the peripheral surface of the rotating photosensitive drum 1 to preset polarity and potential level. Shown in Figure 1 is a charging apparatus of the contact type, which employs a charge roller.

[0021]

Designated by a referential symbol 3 is a means for exposing the photosensitive drum 1 to a beam of light which reflects image formation data. In this embodiment, the exposing means is a laser beam scanner. This scanner 3 is made up of a semiconductor laser, a polygon mirror, an F-θ lens, etc. It forms an electrostatic latent image by scanning (exposing thereby) the uniformly charged surface of the photosensitive drum 1 with the beam of laser light which it emits while turning it on and off according to the image data sent from an unshown host apparatus. Designated by a referential symbol 3a in the drawing is a deflection mirror.

[0022]

Designated by a referential symbol 4 is a

developing apparatus, which develops the electrostatic latent image into an image formed of toner (which hereinafter may be referred to as toner image). As the developing method, the jumping developing method, two-component developing method, or the like is used. In most cases, it is used in combination with the exposing process and reversal developing process.

[0023]

Designated by a referential symbol 5 is a transfer roller as a charging member of the contact type. The transfer roller 5 is rotatably shaped and has an elastic layer. It is kept pressed upon the photosensitive drum 1, forming a transfer nip N. It is rotationally driven by a driving means B in the counterclockwise direction indicated by an arrow mark, at a preset peripheral velocity. The structure, functions, etc., of this transfer roller 5 will be described in detail in the following section, that is, Section (2).

[0024]

In the transfer nip N, the toner image formed on the rotating photosensitive drum 1 is electrostatically transferred, as if it were rolled out of the photosensitive drum 1, onto a sheet of recording medium P (sheet of material onto which image is to be transferred) delivered to the transfer nip N from a paper feeding portion 7 through a paper feeding

path 9. Designated by a referential symbol 8 is a paper feeding roller.

[0025]

The recording medium P fed from the paper feeding portion 7 or 14 by the paper feeding roller 8 or 15 is kept on standby at a pre-feed sensor 12, and then, is delivered to the transfer nip N (image forming portion) through a pre-transfer guide 13. The recording medium P is delivered to the transfer nip N formed by the photosensitive drum 1 and transfer roller 5, in synchronism with the arrival of the toner image (formed on photosensitive drum 1) at the transfer nip N. The synchronization between the arrival of the recording medium P at the transfer nip N and that of the toner image is accomplished by a registration sensor 12.

[0026]

After moving past the transfer nip N while receiving the toner image, the recording medium P is separated from the surface of the photosensitive drum 1, and conveyed to a fixing apparatus 18 through a sheet path 17. The fixing apparatus 8 in this embodiment is a fixing apparatus of the heat roller type, which is made up of a pair of rollers, that is, a heat roller 18a and a pressure roller 18b. The recording medium P bearing the toner image is conveyed through a fixation nip T, while remaining pinched

between the two rollers 18a and 18b. The fixation nip T is a pressure nip formed between the heat roller 18a and pressure roller 18b by keeping the two rollers 18a and 18b pressed against each other. As the recording medium P is conveyed through the fixation nip T, it is subjected to heat and pressure. As a result, the toner image is fixed to the surface of the recording medium P; the toner image is turned into a permanent image. After the fixation of the toner image to the recording medium P, the recording medium P is discharged from the apparatus main assembly by a pair of discharge rollers 19; it is discharged into a delivery tray 20.

[0027]

Meanwhile, the surface of the photosensitive drum 1, from which the toner image has just been transferred onto the recording medium P, is cleaned by a cleaning apparatus 6; the toner particles remaining on the surface of the photosensitive drum 1 are removed by the cleaning apparatus 6. The cleaned surface of the photosensitive drum 1 is used for the following image formation cycle; the surface of the photosensitive drum 1 is repeatedly used for image formation. The cleaning apparatus in this embodiment is a cleaning apparatus of the blade type. A referential symbol 6a designates the cleaning blade of the cleaning apparatus 6.

[0028]

(2) Transfer Roller 5

Figure 2 is an enlarged schematic side view of one of the lengthwise ends of the transfer roller 4, and its adjacencies, and Figure 3 is a schematic front view of the transfer roller, a part of which is not shown.

[0029]

The transfer roller 5 is a solid rubber roller, which is made up of a metallic core 5a formed of iron, SUS, or the like, and a solid elastic layer 5b formed around the metallic core 5a, of EPDM, silicon, NBR, urethane, or the like substance. The electrical resistance of the elastic layer is in the medium range. In the present invention, an elastic roller, the hardness of which is in the range of 40 - 80 degrees, preferably, 50 - 70 degrees, in ASKER-C scale, when it is under a load of 1 kg, and the electrical resistance value of which is in the range of 10^6 - 10^{10} Ω, is used. The elastic layer 5b of the transfer roller 5 is subjected twice to the vulcanizing process; it is subjected to the primary and secondary vulcanization processes. Thereafter, its surface is polished to reduce its external diameter to a preset measurement. Then, the surface is further treated.

[0030]

As for the condition for the primary vulcanization, it has only to be set according to the

type of the base polymer of the rubber, and additives such as vulcanizing agent, softener, plasticiser, etc., so that the elastic layer 5b is optimally vulcanized. Normally, the vulcanizing process is carried out for 10 - 60 minutes at a temperature level roughly in the range of 100 - 200°C. As for the condition for the secondary vulcanization, it has only to be set so that the temperature level at which the secondary vulcanization is carried out is close to, or higher than, the temperature level for the primary vulcanization. When the temperature level for the secondary vulcanization is close to that of the primary vulcanization, the difference between the two temperature levels is desired to be no more than 40°C, preferably, no more than 20°C. Normally, the temperature level for the secondary vulcanization is desired to be set to a value in the range of 120°C - 200°C, preferably, 130°C - 200°C. As for the duration of the secondary vulcanization, it has only to be greater than that of the primary vulcanization, although it should be adjusted according to the temperature level for the secondary vulcanization. Normally, it is desired to be no less than 30 minutes, preferably, no less than 40 minutes. However, if the secondary vulcanization is carried out too long, the deterioration of the rubber proportionally worsens. Therefore, the length of the secondary vulcanization

is desired to be no more than roughly 120 minutes, preferably, roughly 80 minutes.

[0031]

After the secondary vulcanization, the roller is left at room temperature so that it will naturally cool down. Then, its elastic layer is polished to reduce the external diameter of the roller to a desired value. Carrying out the primary and secondary vulcanization processes, and the polishing process, in the order of the primary vulcanization process, polishing process, and secondary vulcanization process, is effective to render the photosensitive drum 1 more resistant to contamination. However, this allows the heat applied for the secondary vulcanization process to reduce the roller in external diameter, allowing thereby the deviation in the external diameter of the roller to increase to a value in the range of ñ0.1 - ñ0.15 [mm] when the roller is mass-produced. In order to keep the solid transfer roller stable in the recording medium conveyance speed, the deviation in the external diameter of the solid transfer roller is desired to be kept within the range of ñ0.05 [mm]. However, in the case of the manufacturing method in which the secondary vulcanization process is carried out after the polishing process, it is difficult to keep the deviation in the external diameter of the roller within the abovementioned range. By carrying

recording medium conveyance speed, which is attributable to the direction in which the surface of the transfer roller is polished and the nonuniformity in the surface roughness of the roller, and further, paper dust, toner, and the like are prevented from adhering to the roller surface. Therefore, not only is the image forming apparatus enabled to form satisfactory images for a long time, but also, the problem that the ingredients of the transfer roller seep out from within the transfer roller and contaminate a photosensitive drum can be prevented.

[0034]

As for the irradiation of the transfer roller with ultraviolet rays, the roller surface is irradiated with such ultraviolet rays that are 200 - 450 nm in wavelength. The duration of the irradiation has only to be roughly in the range of 1 - 10 minutes.

[0035]

Ultraviolet rays must be evenly irradiated across the surface of the rubber layer of the transfer roller. As the method for evenly irradiating the surface of the rubber layer of the transfer roller, the method in which the roller is rotated relative to an ultraviolet ray source, or the method in which ultraviolet rays are irradiated upon the roller from above and below the roller, or the like method, may be

used.

[0036]

The light source does not need to be limited to the abovementioned one. That is, any light source will suffice as long as it can emit ultraviolet rays, the wavelength of which is in the abovementioned range. More specifically, one of the known light sources, for example, a hydrogen lamp, a heavy hydrogen lamp, a halogen lamp, a xenon lamp, etc., may be used. Further, it is desired to use such a lamp that is 80 W/cm in output, and 4,000 W in rated electric power.

[0037]

As the method for treating the surface of the transfer roller with ozone, there is the method in which the transfer roller is left for roughly 0.5 - 2 hours in an ambience, the ozone density of which is in the range of 10 - 30 ppm ($x10^{-2}$), and the temperature of which is in the range of 35 - 40°C.

[0038]

As for the method for measuring the electrical resistance of the transfer roller 5, referring to Figure 7, the maximum and minimum values of the voltage generated between the two ends of a resistor 74 are read with the use of a voltmeter 73, while the transfer roller 5, which is kept in contact with an aluminum cylinder with the application of a total pressure of 1,000 g (500 g per side) is rotated, and

voltage (optional in value, for example, +2.0 kV) is applied to the metallic core 5a of the transfer roller 5 from a high voltage DC power source 72. Then, from the obtained voltage values, the average value of the electric current which flowed through the circuit is obtained, and then, the electrical resistance value of the transfer roller is calculated (measurement ambience: N/N $\cdot 20^\circ C 60\%$).

[0039]

Referring to Figure 3, the transfer roller 5 is disposed in parallel to the photosensitive drum 1. It is rotatably supported by a pair of bearings 5c, one bearing at each of the lengthwise ends of its metallic core 5a, and is kept pressured toward the photosensitive drum 1 by a pair of pressure application springs 5d, which generate a total pressure of 0.5 - 2.0 kg, so that the elastic layer 5b is pressed upon the photosensitive drum 1 to form the transfer nip N.

[0040]

A referential symbol 5e in Figure 3 designates a gear rigidly attached to one of the lengthwise ends of the metallic core 5a of the transfer roller 5. With this gear, an unshown drive gear is meshed. Thus, the rotational force of the drive gear is transmitted to the gear 5e, rotationally driving the transfer roller 5 in the counterclockwise direction indicated in

Figure 2 at a preset peripheral velocity.

[0041]

Designated by a referential symbol 21 is an electric power source for transfer bias application. From this electric power source, transfer bias is applied to the transfer roller 5 through the electrically conductive pressure application springs 5d, bearings 5c, and metallic core 5c. The recording medium P is delivered from the paper feeding portion to the transfer nip N with preset timing, and then, is conveyed through the transfer nip N while remaining pinched in the transfer nip N. While the recording medium P is conveyed through the transfer nip N, a desired voltage, which is opposite in polarity to the toner image on the photosensitive drum 1, is applied from the electric power source 21 for transfer bias application, to the transfer roller 5, giving electric charge to the recording medium P in the transfer nip N. As a result, the toner image on the photosensitive drum 1 is electrostatically transferred onto the recording medium as if the toner image were rolled out onto the recording medium P from the photosensitive drum 1.

[0042]

[Embodiment]

Next, the present invention will be concretely described in the form of embodiments. However, the

following embodiments of the present are not intended to limit the scope of the present invention.

[0043]

Embodiment 1

The transfer roller 5 used in this embodiment is an electrically conductive elastic roller, which is made up of a metallic core 5a, and an elastic layer 5b (electrical resistance of which is in mid range) formed around the metallic core 5a. The metallic core 5a is formed of Fe, and is 6 [mm] in diameter. The elastic layer 5b is formed of ion-conductive solid rubber, which belongs to NBR group, and is 5×10^8 Ωin electrical resistance. The transfer roller 5 is 65 degrees in hardness (ASKER-C scale/total load of 1,000 g), and is 18 [mm] in external diameter.

[0044]

Figure 5 shows the general flow of the manufacturing process for the transfer roller 5 in this embodiment. First, a layer of the ion-conductive rubber, which belongs to NBR group, is formed as the elastic layer, around the metallic core; it is formed by injection molding, press molding, or extrusion molding, and then, the metallic core is pressed into the center of the elastic rubber layer. Then, the elastic layer (rubber layer) is vulcanized (primary vulcanization process). In this embodiment, the elastic layer is formed by injection molding, and

vulcanized in the mold for the injection molding for 30 minutes at 140°C (heating condition).

[0045]

Next, the transfer roller is removed from the molding machine, and vulcanized (secondary vulcanization process) at the same temperature as, or a higher temperature than, that for the primary vulcanization process. The secondary vulcanization process is carried out with the use of a batch furnace.

[0046]

Tables 1 and 2 show the heating conditions for the secondary vulcanization process, and the results of the photosensitive drum contamination tests. Table 1 shows the results of the test in which the heating time was kept at 60 minutes, whereas the heating temperature was varied. Table 2 shows the results of the test in which the heating temperature is kept at 150°C, whereas the heating time is varied in duration. As for the photosensitive drum contamination test, the transfer roller completed by being polished and exposed to ultraviolet rays after the second vulcanization process was pressed upon the photosensitive drum with the application of a total pressure of 1 kg, and then, was left unattended for a week in a constant temperature chamber, the internal temperature and humidity of which were set to 50°C and 95 %, respectively (severe ambience). Then, the images

formed with the use of this transfer roller along with a photosensitive drum were examined, yielding the results given in Tables 1 and 2. More specifically, after the transfer roller was left unattended in the above described severe ambience, images of a solid black original were outputted, and then, the images were evaluated. When the prints yielded using a given transfer roller suffered from unintended white strips attributable to the substances which seeped out of the transfer roller, the transfer roller was rated as NG (×), and when the prints yielded using a given transfer roller suffered from a small number of the unintended white strips, the transfer roller was rated as (Δ). When the prints yielded using a given transfer roller did not suffer at all from the unintended white strip, the transfer roller was rated as (○). For comparison, the tables show the results of the tests of the transfer rollers produced through a manufacturing process in which a precursor of a transfer roller was polished and exposed to ultraviolet rays without being subjected to the second vulcanization process.

[0047]

[Table 1]

2nd Vulc.Temp.	No	100	130	150	180	200
(Vulc.Time 60min.fixed)	(COMP.EMB.1)					

White Strip Level (EMB.1)	×	△	○	○	○	○

[0048]

[Table 2]

2nd Vulc.Time (Vulc.Temp 150℃fixed)	No (COMP.EMB.1)	15	30	45	60	75
White Strip Level (EMB.1)	×	×	△	○	○	○

[0049]

The following are evident from Tables 1 and 2. In the case of the comparative transfer roller, that is, the transfer roller produced using the manufacturing process which did not include the secondary vulcanization process, the photosensitive drum was contaminated with the substances having seeped out of the transfer roller, and as a result, the outputted images which were to be solid black images suffered from unintended white strips. In the case of a transfer roller produced using the manufacturing process which included the secondary

vulcanization process, the outputted images which were to be solid black images did not suffer from the unintended white strips as much as the images yielded with the use of the comparative transfer roller (unintended white strips on image were dimmer and less recognizable), or did not suffer at all from the unintended white strips. This occurred because the substances responsible for the contamination of the photosensitive drum, for example, the by-products of the primary vulcanization process, residual portion (portion that did not react) of the vulcanization agent, low molecule components of the rubber, which did not bridge, etc., were purged from within the elastic layer by the secondary vulcanization process.

[0050]

Further, regarding the effect of the heating temperature upon the effectiveness of the secondary vulcanization process, it is evident from Table 1 that the secondary vulcanization process is somewhat effective even when the heating temperature is roughly 30°C, and also, that the secondary vulcanization process is more effective when the heating temperature is no less than 30°C. Transfer rollers different in material were formed and were subjected to the same tests as the above described ones. As a result, it became evident that the secondary vulcanization process was highly effective when it was carried out

so that the heating temperature therefor was close to, or higher than, the heating temperature for the primary vulcanization process. Further, regarding the length of time the precursor of a transfer roller is heated, it is evident from Table 2 that the longer the heating time, the greater the effect of the secondary vulcanization process upon the prevention of the photosensitive drum contamination.

[0051]

Shown in Figure 5 is the relationship between the heating temperature for the secondary vulcanization process and the electrical resistance value of the transfer roller. As the secondary vulcanization process was varied in the heating temperature, the resultant transfer rollers were different in electrical resistance value as shown in Figure 5. This occurred because the surface of the elastic layer was deteriorated by the secondary vulcanization process, increasing the transfer roller in electrical resistance value. The changes in the electrical resistance of the transfer roller attributable to the deterioration of the surface of the elastic layer caused by the secondary vulcanization process was not consistent. That is, if the surface of the elastic layer is deteriorated too much, the transfer roller manufacturing process is reduced in the reproducibility of the electrical

resistance of a transfer roller. Therefore, the deterioration of the surface of the elastic layer attributable to the second vulcanization process needs to be minimized. Thus, the temperature for the secondary vulcanization process is to be set in consideration of the decrease in the strength of the elastic layer of a transfer roller, which is attributable to the deterioration of the surface layer of the elastic layer, and also, in consideration of the changes in the electrical resistance value of the transfer roller, which is attributable to the increase in the electrical resistance of the deteriorated portion of the surface of the elastic layer.

[0052]

As described before, the secondary vulcanization process is effective to prevent the photosensitive drum contamination, when the vulcanization temperature is roughly 130°C or higher. However, if the vulcanization temperature is higher than 200°C, the deterioration of the elastic layer becomes excessive, making it likely for a transfer roller to deviate in electrical resistance value. Further, the worsening of the deterioration has an additional ill effect. That is, the amount by which a transfer roller is worn across its peripheral surface as the recording paper P is conveyed through the transfer nip N increases, and therefore, as the

cumulative length of transfer roller usage increases, the transfer roller substantially reduces in diameter. Thus, the temperature for the secondary vulcanization process is desired to be set to a value within the range of 130°C - 200°C.

[0053]

In this embodiment, the secondary vulcanization process was carried out for 60 minutes at 180°C, in consideration of the effect of the secondary vulcanization process upon the prevention of the photosensitive drum contamination, the rubber deterioration and resultant increase in the electrical resistance value of the transfer roller, and the productivity in the mass-production of a transfer roller.

[0054]

Shown in Figure 6 is the relationship between the polishing amount (amount by which transfer roller is shaved by polishing) and the electrical resistance value of the polished transfer roller.

[0055]

As is evident from Figure 6, after the secondary vulcanization process, the electrical resistance value of a transfer roller was affected by the amount by which the transfer roller was shaved away as the transfer roller was polished. This occurred because the outermost portion of the elastic

layer, which had been increased in electrical resistance value because it had been deteriorated by the secondary vulcanization process, was shaved away by the polishing process. Thus, in order to prevent the secondary vulcanization process from making transfer rollers different in electrical resistance value, the aforementioned polishing amount is desired to be set to a value no less than 0.1 mm. However, if the polishing amount is set to an excessively large value, it becomes easier for the potential contaminants of the photosensitive drum, which remain on the inward side of the elastic layer of the transfer roller even after the second vulcanization process, to seep out. Thus, from the standpoint of the prevention of the photosensitive drum contamination, the polishing amount is desired to be set to a value no more than 0.4 mm. In this embodiment, it was set to roughly 0.15 mm.

[0056]

Lastly, in the present invention, the elastic layer formation process, primary vulcanization process, secondary vulcanization process, and polishing process are all completed in the listed order, and then, a transfer roller is subjected to the process for treating a transfer roller with ultraviolet rays or the process for treating a transfer roller by bombarding with ozone, as the finishing process, to

give a surface treatment to the elastic layer of the transfer roller. This surface treatment is effective to reduce the elastic layer surface in roughness, being therefore effective to reduce the transfer roller in the nonuniformity of the surface properties, which is attributable to the polishing process. In other words, the surface treatment is effective to stabilize a transfer roller in recording medium conveyance speed. Further, the surface treatment reduces a transfer roller in adhesiveness of the surface of the elastic layer, preventing thereby the adhesion of the paper dust resulting from a printing operation and/or the adhesion of toner. Therefore, it prevents the formation of an inferior image, the inferiority of which is attributable to the changes in the electrical resistance of the surface of a transfer roller, which is caused by the adhesion of foreign substances to the surface of the transfer roller, which occurs as the cumulative usage of the transfer roller increases. As the surface treatment in this embodiment, the transfer roller was irradiated with ultraviolet rays by keeping an ultraviolet ray lamp, the wavelength of which is in the adjacencies of 250 nm, turned on for three minutes.

[0057]

As described above, by subjecting the precursor of a solid transfer roller having a single

elastic layer formed of solid robber, to the secondary vulcanization process in which heating temperature is in the range of 130°C - 200°C, for a length of time longer than that for the primary vulcanization process, after the first vulcanization step, the residual ingredients, which remain in the single elastic layer of the transfer roller after the primary vulcanization process, and which possibly seep out onto the surface of the elastic layer, can be removed to prevent the contamination of a photosensitive drum. Further, by polishing the peripheral surface of a transfer roller after the secondary vulcanization process, it is possible to manufacture a transfer roller which is highly accurate in external diameter. Further, by this polishing of the peripheral surface of a transfer roller, the portion of the surface of the elastic layer, which has been deteriorated by the second vulcanization process is removed by a small amount to render uniform the surface of the elastic layer in electrical resistance value. Further, by subjecting a transfer roller to such a surfacing treating process as irradiating a transfer roller with ultraviolet rays, bombarding a transfer roller with ozone, or the like process, as the finishing touch, it is possible to obtain a transfer roller which is excellent in the stability with which the recording medium is conveyed, and to the surface of which foreign substances are not

likely to adhere.

[0058]

Embodiment 2

In this embodiment of the present invention, one of the examples of an image forming apparatus, the transfer roller of which is rotated at a peripheral velocity higher than that of its photosensitive drum, is shown.

[0059]

The structure of the image forming apparatus in this embodiment is basically the same as that shown in Figure 1, except that the photosensitive drum and transfer roller of this image forming apparatus are different in the speed at which they are driven. More specifically, the peripheral velocity at which the photosensitive drum in this embodiment is driven is set to 90 % of the process speed, whereas the peripheral velocity of the transfer roller, which can be calculated from the external diameters of the photosensitive drum and transfer roller, and the ratio between the two gears which drive them, is set to 102 % of the process speed. In other words, the transfer roller is rotated faster than the photosensitive drum to convey a recording medium at a speed different from the peripheral velocity of the photosensitive drum. Conveying a recording medium at a speed faster than the peripheral velocity of the

photosensitive drum is effective to cause the recording medium to act in a manner of scraping up the toner on the photosensitive drum, preventing thereby the formation of an image suffering from unintended white areas. According to the present invention, a transfer roller may be rotationally driven at a peripheral velocity different by +0.5 - 6 % from that of a photosensitive drum.

[0060]

In an image forming apparatus, such as the above described one, in which its transfer roller is rotated faster than its photosensitive drum, a recording medium is conveyed through the transfer nip, while continuously slipping on the photosensitive drum and transfer roller. Therefore, the speed at which a recording medium is conveyed through the transfer nip is affected by the thickness of a recording medium, conveyance resistance of a recording medium conveyance path, and print ratio. This variation in recording conveyance speed is also likely to be affected by the amount of pressure applied to keep the transfer roller pressed upon the photosensitive drum. For example, as the conveyance speed is affected (slowed down) by such a factor as paper type, the difference between the speed of a recording medium and the peripheral velocity of the photosensitive drum becomes smaller, failing to be effective to cause the recording medium

to act in a manner of scraping up the toner away from the photosensitive drum. As a result, an image suffering from unintended white areas is yielded. On the other hand, as the conveyance speed increases, the image on the photosensitive drum fails to be transferred onto a recording medium in its entirety; before the trailing end portion of the toner image on the photosensitive drum reaches the transfer nip, the recording medium is conveyed out of the transfer nip, causing the trailing end portion of the toner image to overshoot the trailing end portion of the recording medium. As a result, the problem that the interior of the image forming apparatus is contaminated by toner occurs.

[0061]

In this embodiment, an electrically conductive solid rubber roller is used as the transfer roller. It was made up of a metallic core, and a cylindrical rubber layer formed of ion-conductive high polymer, which belongs to NBR group. More specifically, the cylindrical rubber layer was formed by extrusion molding, and the metallic core was pressed into the center hole of the cylindrical rubber layer. Then, this precursor of the transfer roller was polished after the secondary vulcanization process which was carried out for 60 minutes at 180°C, obtaining the precursor of the transfer roller, which was 16 [mm] in

diameter and 216 mm in the length of the rubber portion. Then, as the finishing process, this precursor was irradiated with ultraviolet rays, which were 250 nm in wavelength, for three minutes, obtaining the ion-conductive solid rubber roller which was 60° in hardness (ASKER-C) under a load of 1 kg.

[0062]

Table 3 shows the various nip widths realized between the above described transfer roller and the photosensitive drum by varying the pressure (total pressure) applied to form the transfer nip, and the amount of the change in the recording medium conveyance speed. The amount ΔX of the change in the recording medium conveyance speed, which is shown here, is the amount of the change in the ratio of the expansion or shrinkage of a given portion of an image in the secondary scan direction, which occurred when the printing ratio was varied within the range of 4 % - 50 % in an image forming operation in which a sheet of paper, the basis weight of which was in the range of 60 - 150 [g/m^2], was used. The ratio of the expansion or shrinkage of a given portion of an image in the secondary scan direction was obtained by measuring the interval of the adjacent two horizontal lines of the image actually formed in accordance with the data of an image having horizontal lines drawn with the intervals of 10 mm. The values in the table

are given in percentages, and a rate of 100 % equals 100 % of process speed. Further, the nip widths given in this table are actual nip widths obtained using the following method: The photosensitive drum, which was kept stationary, was uniformly coated with toner, ink, or the like. Then, the width of the band (stripe) formed by the toner, ink, or the like having adhered to the peripheral surface of the transfer roller as the transfer roller was pressed on the photosensitive drum by applying each of various amounts of load to the lengthwise ends of the transfer roller, was measured (roughly at the center of the band in terms of the lengthwise direction of the transfer roller). The evaluation was made based on the amount of the unintended white areas of the image formed on a postal card. Evaluation references are as follows:

○ : letter did not have unintended white area

Δ : ratio at which letter had unintended white area was 30 - 50 %

× : ratio at which letter had unintended while area was no less than 50 %

[0063]

[Table 3]

Total Pressure[kg]	0.8	1.0	1.3	1.5	2.0
Nip Width[mm]	1.0	1.2	1.5	1.7	2.1

Change in conveyance speed ΔX(%)	99.1-100.5	99.5-100.2	99.7-100.1	99.9-100.1	99.9-100.1
White area on Postal card	×	△	○	○	○

[0064]

The following is evident from Table 3. As the nip width was widened by increasing the amount (total amount) of pressure applied to form the transfer nip, the contact area, in the transfer nip, between a recording medium and the photosensitive drum and the contact area, in the transfer nip, between the recording medium and the transfer roller, increased in size, making it less likely for the external factors such as conveyance resistance and print ratio to cause the transfer roller and recording medium to slip relative to each other. Therefore, the amount ΔX by which the recording medium conveyance speed changed became smaller; the transferring portion was stabilized in recording medium conveying performance. As a result, the formation of an image suffering from unintended white areas is prevented, in particular, even when an image is formed on a thick piece of paper, such as a postal card, the conveyance speed of which

is more likely to be reduced by the above described slippage.

[0065]

Given in Table 4 are the results of the test carried out to evaluate the transfer roller in this embodiment. In the test, the transfer pressure was varied, and the transfer rollers were left pressed upon a photosensitive drum, in an environment in which temperature was 40°C and humidity was 95 %, for one week. The table shows the contact pressures (per unit area) between the transfer roller and photosensitive drum, and the results of the evaluation of the images formed using the transfer rollers and photosensitive drum left unattended under the above described conditions. For comparison, the test results of a transfer roller which was the same in structure as the above described transfer rollers, but, was not subjected to the secondary vulcanization process, are also given. The references used for image evaluation regarding the unintended white strips are as follows:

○ : no unintended white strip was visible

△ : small number of unintended white strips were visible

× : substantial number of unintended white strips were visible

[0066]

[Table 4]

Total Pressure[kg]	0.8	1.0	1.2	1.5	2.0
Contact Pressure[g/mm2]	3.70	3.86	4.01	4.08	4.41
Nip White Strip (EMB.2)	○	○	○	○	△
Nip White Strip (COMP.EMB.2)	○	△	×	×	×

[0067]

As will be evident from Table 4, in the case of the transfer roller in this embodiment, which was subjected to the secondary vulcanization process, when the total amount of pressure applied for image transfer was no more than 1.5 kg, there was no sign, on the photosensitive drum, to suggest that the ingredients of the transfer roller seeped out onto the photosensitive drum. Further, even when solid black images were formed for confirmation, no image suffered from white strips.

[0068]

In the case of the transfer roller (second comparative transfer roller), which had not been subjected to the secondary vulcanization process, as

the total amount of pressure applied for image transfer was increased to 1.2 kg or greater, the solid black images suffered from the white strips attributable to the substances having seeped out of the transfer roller. This occurred for the following reason. That is, the contact pressure per unit area was no less than 40.0 g/mm^2. Therefore, the transfer roller was pressed upon the photosensitive drum by a greater amount of pressure, making it easier for the low molecule ingredients of the solid rubber of the transfer roller to seep out. In comparison, in the case of the transfer roller which had been subjected to the secondary vulcanization process, virtually no seeping occurred when the total amount of the transfer pressure was no more than 2.0 kg.

[0069]

According to Tables 3 and 4, in the case of the transfer roller in accordance with the prior art, that is, the transfer roller, the surface of which was treated with ultraviolet rays without being subjected to the secondary vulcanization process, even though the objective of preventing the photosensitive drum contamination was accomplished, the objectives of stabilizing the recording medium conveyance, and the objective of preventing the formation of an image suffering from unintended white areas (strips), could not be accomplished. In comparison, in the case of the

transfer roller in this embodiment, that is, the transfer roller which had been subjected to the secondary vulcanization process, the abovementioned objectives were all easily accomplished. Further, even when the photosensitive drum and transfer roller were rendered different in driving speed and a high transfer pressure was applied, no image suffering from unintended white areas (strips) was formed, and it did not occur that the trailing end portion of an image overshoots the trailing end portion of a recording medium. Further, it was possible to obtain images which did not suffer from defects attributable to the phenomenon that the ingredients of the transfer roller seep out onto the photosensitive drum.

[0070]

[Effects of Invention]

According to the present invention, which relates to an image forming apparatus having a transferring means of the roller-based transfer method, which employs an electrically conductive solid transfer roller,

(1) By manufacturing a transfer roller with the use of a manufacturing method in which the precursor of a transfer roller is subjected to the secondary vulcanization process before it is polished; thereafter, the precursor is polished across the surface of its rubber portion to give the precursor a

preset external diameter and a desired shape; and then, the surface of the rubber portion is subjected to a surface treatment, such as irradiating with ultraviolet rays, treating with ozone, or the like, the low molecule ingredients of rubber, which are present in the surface portion of the transfer roller, and the additives such as vulcanizing agents, etc., are purged by the secondary vulcanization process, and also, the surface portion of the elastic layer are turned into a seepage prevention layer by the surface treatment, making it thereby possible to prevent the phenomenon that ingredients of the rubber portion of a transfer roller seep out onto the surface of the transfer roller.

[0071]

Further, by giving, after the polishing of the surface of the rubber portion of the transfer roller, the surface of the rubber portion of the transfer roller a surface treatment to smooth the surface of the transfer roller so that the surface becomes no more than 10 μm in roughness index Rz, the changes in the recording medium conveyance speed, which is attributable to the direction in which the surface is polished, the nonuniformity in the surface roughness, are prevented, and the adhesion of paper dust and/or toner to the roller surface is prevented, making it possible for the image forming apparatus to

continuously yield satisfactory images for a long time.

[0072]

(2) By manufacturing a transfer roller with the use of a manufacturing method in which the precursor of a transfer roller is subjected to the secondary vulcanization process before it is polished; thereafter, the precursor is polished across the surface of its rubber portion to give the precursor a preset external diameter and a desired shape; and then, the surface of the rubber portion is subjected to a surface treatment, such as irradiating with ultraviolet rays, treating with ozone, or the like, the low molecule ingredients of rubber, which are present in the surface portion of the transfer roller, and the additives such as vulcanizing agents, etc., are purged by the second vulcanization process, preventing thereby such substances in the transfer roller that possibly contaminate the photosensitive drum, from seeping out of the transfer roller, even under a large amount of transfer pressure, accomplishing thereby the objective of stabilizing the image forming apparatus in the recording medium conveyance in the transfer nip, as well as the objective of preventing the transfer roller from contaminating the photosensitive drum.

[Brief Description of the Drawings]

Figure 1 is a schematic sectional view of an image forming apparatus in accordance with the present invention.

Figure 2 is an enlarged schematic side view of one of the lengthwise ends of the transfer roller, and its adjacencies.

Figure 3 is an enlarged schematic front view of the transfer roller, a part of which has been shown.

Figure 4 is a general flowchart of the manufacturing process for the transfer roller in accordance with the present invention.

Figure 5 is a graph showing the relationship between the temperature for the secondary vulcanization process and the electrical resistance value of the transfer roller.

Figure 6 is a graph showing the relationship between the amount (depth) by which the transfer roller is shaved by polishing , and the electrical resistance value of the transfer roller.

Figure 7 is a drawing roughly showing the method for measuring the electrical resistance value of the transfer roller.

[List of Reference Numerals]

1: photosensitive drum

5: transfer roller

5a: metallic core of transfer roller

5b: elastic layer

5c: bearing for transfer roller

5d: transfer pressure application spring

N: transfer nip

P: recording medium

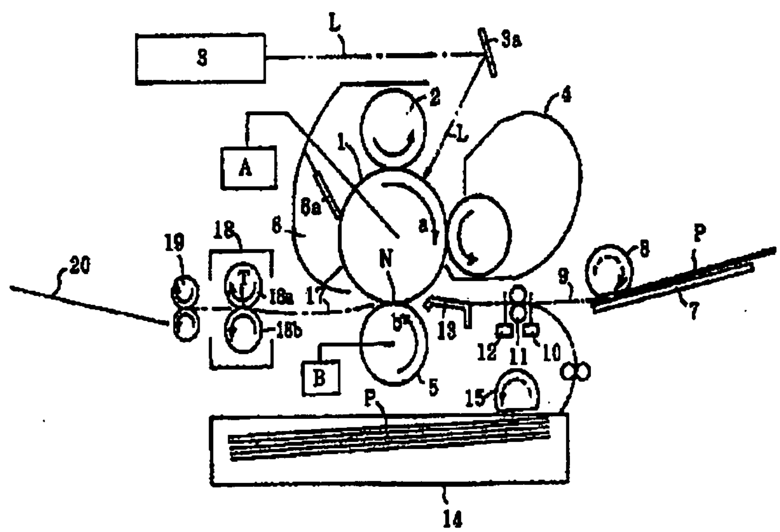


FIG. 1

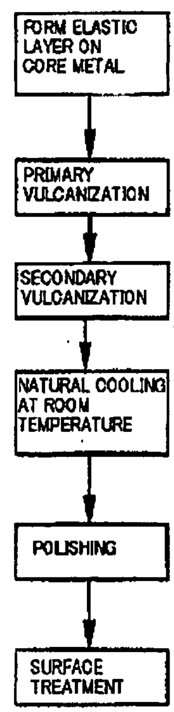


FIG. 4

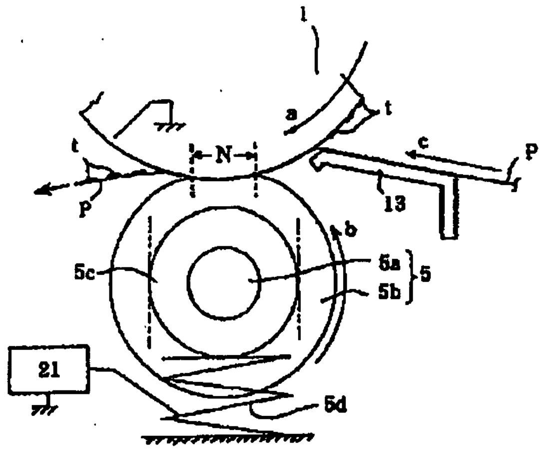


FIG. 2

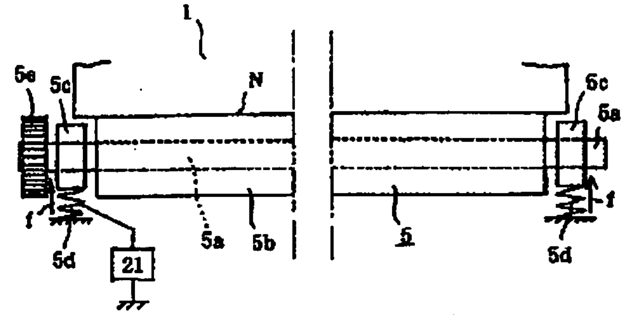


FIG. 3

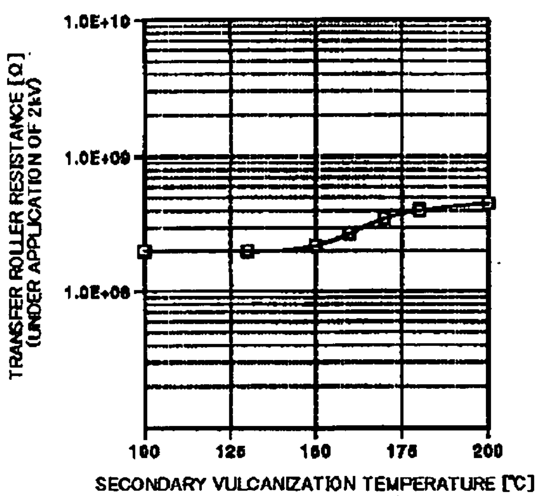


FIG. 5

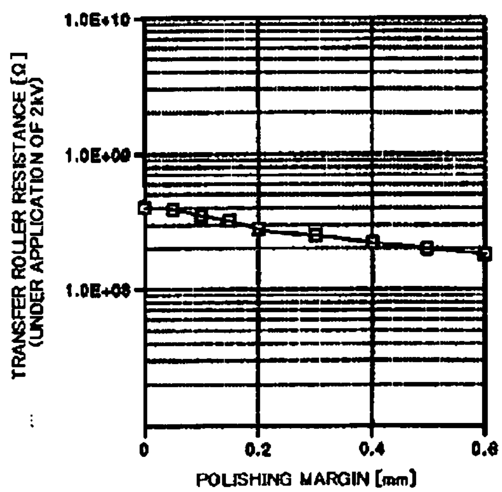


FIG. 6

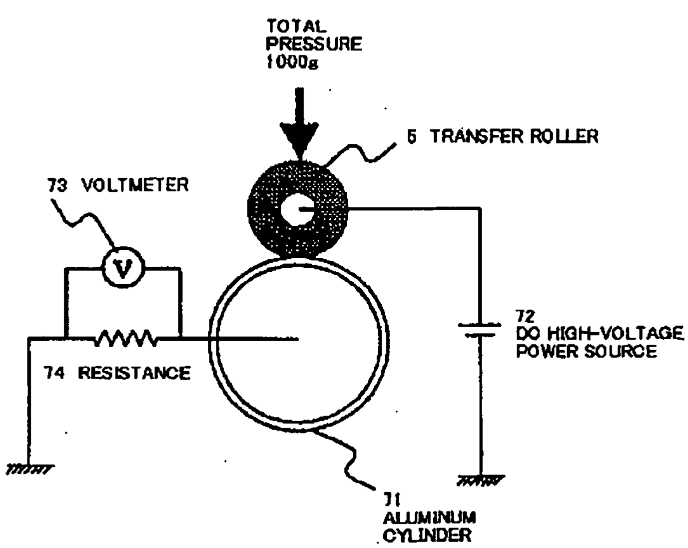


FIG. 7

(19)日本国特許庁（JP）　(12) 公開特許公報（A）　(11)特許出願公開番号

特開平11－109770

(43)公開日　平成11年(1999) 4月23日

(51)Int.Cl.⁶	識別記号	F I	
G03G 15/16	103	G03G 15/16	103
F16C 13/00		F16C 13/00	E
			B

審査請求　未請求　請求項の数7　OL　（全 9 頁）

(21)出願番号　特願平9－268861

(22)出願日　平成9年(1997)10月1日

(71)出願人　000001007
キヤノン株式会社
東京都大田区下丸子3丁目30番2号

(72)発明者　大釜　裕子
東京都大田区下丸子3丁目30番2号　キヤノン株式会社内

(72)発明者　長谷川　浩人
東京都大田区下丸子3丁目30番2号　キヤノン株式会社内

(74)代理人　弁理士　若林　忠　（外4名）

(54)【発明の名称】　転写ローラ及びそれを有する画像形成装置

(57)【要約】

【課題】　含有成分の滲出を防止するバリア層材料や紙粉等の付着を防止する高離型性材料などをソリッド転写ローラの表面にコーティングすることなく、対感光ドラム汚染防止及び搬送力安定性の両立を可能とする転写ローラを有する画像形成装置を提供する。

【解決手段】　芯金上にソリッドゴム層を成形して一次加硫した後に、二次加硫を行い、二次加硫後に研磨をした後に、UV照射等の表面処理を施す。

【特許請求の範囲】

【請求項１】　芯金上にソリッドゴムからなる弾性層を成形して一次加硫した後に、二次加硫を行い、該二次加硫後に研磨をした後に、表面処理を施したことを特徴とする転写ローラ。

【請求項２】　その表面がＲｚ＝１０μｍ以下の平滑な面であることを特徴とする請求項１に記載の転写ローラ。

【請求項３】　前記二次加硫条件が、二次加硫温度１２０～２００℃、二次加硫時間３０～１２０分であることを特徴とする請求項１または２に記載の転写ローラ。

【請求項４】　前記表面処理が、紫外線処理であることを特徴とする請求項１～３のいずれかに記載の転写ローラ。

【請求項５】　前記弾性層が、硬度が１ｋｇ荷重時のＡＳＫＥＲ－Ｃ硬度４０度以上８０度以下のソリッド状ゴムからなることを特徴とする請求項１～４のいずれかに記載の転写ローラ。

【請求項６】　像担持体に当接させた、弾性層を有する回転体形状の接触転写部材を有し、前記像担持体と前記接触転写部材とで形成される転写ニップ部において被記録材を狭持搬送させながら前記像担持体上のトナー像を被記録材上に転写する転写手段を有する画像形成装置において、前記接触転写部材が請求項１～５のいずれかに記載の転写ローラであることを特徴とする画像形成装置。

【請求項７】　前記接触転写部材は、前記像担持体に対し、＋０．５～６％の周速度で回転駆動されることを特徴とする請求項６に記載の画像形成装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は電子写真方式のプリンター、複写機および静電記録装置等、特にローラ転写方式を採用する画像形成装置に関に関し、特に該画像形成装置に使用される転写ローラの改良に関する。

【０００２】

【従来の技術】従来、電子写真方式の画像形成装置の多くは、有害とされているオゾンの発生が非常に少ない接触転写方式を採用しており、なかでも転写部での被記録材搬送性に優れたローラ転写方式が主流となっている。

【０００３】ローラ転写方式は、弾性ゴムローラ層を有する転写ローラを像担持体である感光ドラムに圧接して転写ニップを形成し、前記転写ニップで被記録材を搬送しつつ、転写ローラに印加された転写バイアスの作用で感光ドラム上のトナー像を被記録材上へ転写するものである。

【０００４】転写ローラは一般的に、ＳＵＳ、Ｆｅ等の芯金上にカーボン、イオン導電性フィラー等によりその抵抗を1×10^{6}～1×10^{10}［Ω］とした導電性スポンジ弾性体層を形成した硬度２０～４０度（ＡＳＫＥＲ－Ｃ）の弾性スポンジローラが用いられている。また近年、様々な被記録材に印字する市場の要求が高まるに従い、より搬送性に優れた導電性ソリッドゴムを弾性層としたソリッド転写ローラを用いた画像形成装置も開発されている。

【０００５】ソリッド転写ローラは、その弾性層が高い復元力を有するソリッド状ゴムであるため、従来のスポンジタイプの転写ローラに比較して転写ニップ部での被記録材保持力が高く、給紙のバックテンションや、葉書や厚紙などが被記録材搬送路にこすれて生じる搬送抵抗などに対しても影響を受けにくく、より安定した被記録材搬送が行えるというメリットがある。特に、感光ドラムに対して転写ローラを速回し駆動し、被記録材を感光ドラムよりも速送りすることで感光ドラム上からトナーを掻き取る効果を持たせて中抜けを防止する、いわゆる転写速回し系の画像形成装置において、スポンジタイプの転写ローラに比べて印字比率の変化による被記録材搬送速度の変化が少ないという特徴がある。

【０００６】

【発明が解決しようとする課題】しかしながら、従来のソリッド転写ローラを用いる画像形成装置では以下に示すような問題があった。

【０００７】（１）転写ローラの弾性層を形成するゴム内には、ベースポリマーを合成する際に投入する反応開始剤の残留物やその際に生成する副生成物、ベースポリマーの低分子成分、ゴムローラ成型時に添加する加硫剤や軟化剤、可塑剤等の成分が含まれる。これらの成分は、感光ドラム表層と反応しやすいものが多く、長時間転写ローラと感光ドラムを圧接した状態で放置すると、これらの成分が転写ローラより滲出して感光ドラムに付着し、反応して感光ドラム表面を改質してしまうという問題がある。

【０００８】特に、ソリッド転写ローラはスポンジ状ゴムを弾性層とするスポンジ転写ローラに比較して硬度が高く、転写ニップ幅が狭くなるために単位面積当たりの感光ドラムに対する圧接力が高くなる傾向にある。そのため、ローラ内に存在する材料ゴムの低分子量成分や加硫剤・可塑剤等が転写ローラ表面に滲出しやすく、転写ローラが感光ドラムと圧接固定した状態のまま長時間おかれた場合、感光ドラム表面に滲出した物質が付着して画像を乱す、またひどい場合は感光ドラム表面が反応・改質されて白化してしまい、以降の画像を全て乱してしまうという問題がある。

【０００９】また、ソリッド転写ローラは表面の粘着性が大きいため、通紙によって紙粉、トナー等が付着して表面が汚れてしまい、その付着物によってローラの表面抵抗が変化するために適正な転写電流が均一に流れなくなって、異常画像が発生するという問題があった。

【００１０】これらの問題を解決するために、転写ローラ表面に含有成分が滲出するのを防止するバリア層とな

る物質をコーティングすることが考えられるが、ローラが複数層構成となり、材料費が増えること及び製造工程が複雑になるために転写ローラのコストが高くなるという問題があった。

【0011】また、紙粉の付着に対しても転写ローラ表面に離型性の良い材料をコーティングすることで付着を防止することが考えられるが、高離型性材料は一般的にコストが高く、これも転写ローラコストを高くしてしまうという問題があった。

【0012】（2）転写速回し系の画像形成装置では、被記録材が感光ドラムと転写ローラの間でスリップしながら搬送されるために、被記録材搬送速度が転写ローラの外径変化や表面性の変化、被記録材搬送路内の搬送抵抗などによって大きくスピードが変化し、中抜けの防止効果が低下したり、画像が被記録材後端からはみ出して装置内部を汚すという問題があった。ソリッド転写ローラはローラ自身の搬送力が高く、スポンジタイプの転写ローラと比較すると転写ニップ部での被記録材搬送速度は安定しているが、依然として転写ニップ部での被記録材搬送速度の変化は生じていた。

【0013】この被記録材搬送スピードの変化を小さくするためには、感光ドラムに対する転写ローラの圧接力を高くし、転写ニップ部での被記録材保持力を高めることが有効だが、ソリッド転写ローラは硬度が高く、転写圧接力を高くすると転写ニップ部での単位面積当たりの加圧力が急激に上昇し、転写ローラ内部から感光ドラムを汚染する物質の滲出が増大するため、対感光ドラム汚染防止と搬送力安定性の両立が困難であった。

【0014】本発明の目的は、含有成分の滲出を防止するバリア層材料や紙粉等の付着を防止する高離型性材料などをソリッド転写ローラの表面にコーティングすることなく、対感光ドラム汚染防止及び搬送力安定性の両立を可能とする転写ローラを有する画像形成装置を提供することにある。

【0015】

【課題を解決するための手段】上記問題を解決するために、本発明では、芯金上にソリッドゴムからなる弾性層を成形して一次加硫した後に、二次加硫を行い、該二次加硫後に研磨をした後に、表面処理を施すことにより、バリア層材料や高離型性材料などを転写ローラの表面にコーティングすることなく、対感光ドラム汚染防止及び搬送力安定性の両立を可能とする転写ローラの提供が可能となる。

【0016】

【発明の実施の形態】本発明は、導電性ソリッド転写ローラを用いるローラ転写方式の転写手段を有する画像形成装置において、

（1）転写ローラを研磨前に二次加硫処理をし、その後研磨を行い外径形状を所望の形状とした後に、ゴム部表面に研磨後にＵＶ処理やオゾン処理等の表面処理を施すことで、転写ローラ表面に存在するゴムの低分子成分や、加硫剤等の添加物を二次加硫によって飛ばすと共に、表面処理によって弾性層表面を滲出防止層に改質し、転写ローラ表面へのゴム内部物質の滲出を防止する。

【0017】また、転写ローラゴム部表面を研磨後に表面処理して転写ローラ表面をＲｚ＝１０μｍ以下の平滑な面とすることで、研磨目の方向や表面粗さのばらつきによる被記録材搬送速度の変化をおさえると共に、ローラ表面への紙粉やトナーの付着を防止して、長期に亘り良好な画像を維持するものである。

【0018】（2）転写ローラを研磨前に二次加硫処理をし、その後研磨を行い外径形状を所望の形状とした後に、ゴム部表面に研磨後にＵＶ処理やオゾン処理等の表面処理を施すことで、転写ローラ表面に存在するゴムの低分子成分や、加硫剤等の添加物を二次加硫によって飛ばし、高い転写圧接力をかけても転写ローラ内部から感光ドラムに対して汚染物質が滲出するのを防止し、転写ニップ部での被記録材搬送安定性と対感光ドラム汚染防止の両立を可能とするものである。

【0019】以下、本発明について詳細に説明する。

（１）画像形成装置

図１は本発明を適用する画像形成装置の略断面図である。図１において、１は像担持体たる感光ドラムであり、ＯＰＣ、アモルファスＳｉ等の感光材料をアルミニウムやニッケル等のシリンダ状の基体上に形成して構成されており、駆動手段Ａにより矢示の時計方向ａに所定の周速度で回転駆動される。

【0020】２は回転する感光ドラム１の周囲を所定の極性・電位に一様に帯電処理する帯電手段であり、図１では帯電ローラを使用した接触帯電装置を示している。

【0021】３は画像情報露光手段であり、本例ではレーザービームスキャナーを用いている。このスキャナー３は、半導体レーザー、ポリゴンミラー、Ｆ－θレンズ等を有してなり、不図示のホスト装置から送られてきた画像情報に応じてＯＮ／ＯＦＦ制御されたレーザービームＬを出射して感光ドラム１の一様に帯電された表面を走査露光し、静電潜像を形成する。図中３ａは折り返しミラーである。

【0022】４は現像装置であり、感光ドラム１上の静電潜像をトナー像として現像する。現像方法としては、ジャンピング現像法、２成分現像法等が用いられ、イメージ露光と反転現像との組み合わせで用いられることが多い。

【0023】５は弾性層を有する回転体形状の接触帯電部材としての転写ローラであり、感光ドラム１に対して加圧接触させて転写ニップ部Ｎを形成させてあり、駆動手段Ｂにより矢示の反時計方向ｂに所定の周速度で回転駆動される。この転写ローラ５の構成・作用等については次の（２）項において詳述する。

【0024】回転感光ドラム1上に形成されたトナー像は、転写ニップ部Nにおいて、給紙部7から給紙経路9を介して給紙された被記録材P（被転写材）に対して順次静電転写される。8は給紙ローラーである。

【0025】給紙部7又は14から給紙ローラ8又は15によって給紙された被記録材Pは、プレフィードセンサ10で待機した後に、レジストローラ11、レジストセンサ12、転写前ガイド13を介して転写ニップ部N（画像形成部）に給紙される。被記録材Pは、レジストセンサ12によって、感光ドラム1の表面に形成されたトナー像と同期取りされて、感光ドラム1と転写ローラ5とで形成される転写ニップ部Nに供給される。

【0026】転写ニップ部Nにおいてトナー像の転写を受け、転写ニップ部Nを通過した被記録材Pは、感光ドラム1の面から分離され、シートパス17を通って定着装置18へ搬送される。本例の定着装置18は加熱ローラ18aと加圧ローラ18bの圧接ローラ対からなるヒートローラ定着装置であり、トナー像を保持した被記録材Pは加熱ローラ18aと加圧ローラ18bの圧接部である定着ニップ部Tで狭持搬送されて加熱・加圧を受けることでトナー像が被記録材P上に定着され永久画像となる。トナー像が定着された被記録材Pは排出ローラー19を介して排紙トレー20に排紙されて機外に排出される。

【0027】一方、被記録材Pに対するトナー像転写後の感光ドラム1の表面は、クリーニング装置6により転写残留トナーの除去を受けて清掃されて繰り返して作像に供される。本例のクリーニング装置6はブレードクリーニング装置であり、6aはそのクリーニングブレードである。

【0028】(2) 転写ローラ5

図2は転写ローラ部分の一端側の拡大側面模式図、図3は転写ローラの途中部分省略の正面模式図である。

【0029】転写ローラ5は鉄、SUS等の芯金5a上にEPDM、シリコーン、NBR、ウレタン等のソリッド状の中抵抗弾性層5bを形成したソリッドゴムローラで、本発明では、1kg荷重時のASKER－C硬度40～80度、好ましくは50～70度、抵抗値10^{6}～10^{10}Ωの範囲のものを使用する。転写ローラ5の弾性体層5bは、一次加硫後に二次加硫し、その後表面を研磨して外径形状を所望の寸法とし、更に表面処理したものを用いる。

【0030】一次加硫は、ゴムのベースポリマーの種類、添加する加硫剤や軟化剤、可塑剤等によって、適宜最適な加硫が行われる条件を設定すればよいが、通常100～200℃程度の温度で10～60分程度行う。また、二次加硫は、一次加硫温度に近い温度もしくはそれよりも高い温度であれば良い。一次加硫温度に近い場合としては、一次加硫温度と二次加硫温度の差が40℃以下、特に20℃以下が好ましい。通常二次加硫温度は、120℃～200℃、好ましくは130℃～200℃の間に設定することが望ましい。また、二次加硫時間は、一次加硫よりも長い時間行えば良く、二次加硫温度によっても異なるが、通常は30分以上、好ましくは40分以上行うのが望ましい。但し、あまり長い時間二次加硫を行うと、それだけゴムの劣化が進行するため、上限としては120分程度、好ましくは80分程度である。

【0031】二次加硫後にローラを室温に放置して自然冷却した後に、弾性層の研磨を行い、外径を所望の値にする。一次加硫後に研磨をし、その後に二次加硫をした場合は感光ドラム汚染に対する効果は高いものの、二次加硫時の加熱により外径が収縮してしまい、量産時の外径精度が±0．1～±0．15［mm］と大きくなってしまう。ソリッド転写ローラの外径精度は、転写部での被記録材搬送スピードを安定させるために±0．05［mm］以内に抑えることが好ましく、研磨後に二次加硫をする製造方法では外径精度を抑えるのが困難である。本発明のように二次加硫を外径研磨前に行うことで、量産時の外径精度を±0．05［mm］以内とすることが容易となる。

【0032】弾性層の研磨方法は、特に限定されるものではなく、従来公知の方法、例えば、円筒研磨法、センタレス研磨法等によって実施することができる。

【0033】表面処理方法としては、紫外線（UV）照射処理、オゾン照射処理など使用する弾性層に適した処理を選択すればよい。該処理を施すと、転写ローラ表面が架橋反応を起こし、ゴム表面のスキン層が硬化し、転写ローラ表面はRz＝10μm以下の平滑な面となる。その結果、研磨目の方向や表面粗さのばらつきによる被記録材搬送速度の変化をおさえると共に、ローラ表面への紙粉やトナーの付着を防止して、長期に亘り良好な画像を維持することができ、更に転写ローラ内部から感光ドラムを汚染する物質の滲出を防止することができる。

【0034】紫外線照射処理としては、200～450nmの波長の光をローラ表面に均一に照射する。処理時間は1～10分程度行えばよい。

【0035】紫外線の照射は転写ローラのゴム表面に均一に照射させる必要があり、紫外線光源に対してローラを回転させるか、ローラをコンベアーで送りながら上下方向から紫外線を照射するなどの方法を用いる。

【0036】光源としては前記波長範囲の紫外線を照射できるものであれば特に限定されないが、例えば、水素ランプ、重水素ランプ、ハロゲンランプ、キセノンランプ等の公知の光源が使用でき、例えば、ランプ出力80W／cm、定格電力4000Wのものを使用するのが好ましい。

【0037】オゾン照射処理は、例えばオゾン濃度10～30pphm（$\times10^{-2}$）、温度35～45℃の雰囲気に、転写ローラを0．5～2時間程度放置する方法が挙げられる。

【0038】転写ローラ5の抵抗測定法は、図7に示すように、アルミシリンダー71へ総圧1000g（片側500g）で転写ローラ5を当接させて回転させ、任意の電圧（たとえば＋2．0kV）を直流高圧電源72より転写ローラ芯金5aに印加したときに抵抗74の両端に発生する電圧値の最大値、最小値を電圧計73で読みとる。読みとった電圧値から回路中に流れる電流値の平均値を求め、転写ローラの抵抗値を算出する（測定環境はN／N・20℃60％）。

【0039】図3に示すように、転写ローラ5は感光ドラム1に平行して配置され、芯金5aの両端部を軸受け部材5cによって回転自在に保持させるとともに、加圧バネ5dにより感光ドラム方向に加圧付勢させて弾性層5bを感光ドラム1に総圧0．5〜2．0kgで加圧圧接させて転写ニップ部Nを形成させてある。

【0040】図3中の5eは転写ローラ5の芯金5aの一端部に固着させたギアであり、このギアに不図示のドライブギアを噛み合わせてあり、ドライブギアの回転力がギア5eに伝達されて転写ローラ5が図2の矢示の反時計方向bに所定の周速度で回転駆動される。

【0041】21は転写バイアス印加電源であり、この電源21から導電性の加圧バネ5d・軸受け部材5c・芯金5aを介して転写ローラ5に対して転写バイアスが印加される。給紙部から所定の制御タイミングで転写ニップ部Nに給紙された被記録材Pは転写ニップ部Nで狭持搬送される間、転写バイアス印加電源21より転写ローラ5に対して感光ドラム上のトナー像と逆極性の所望の電圧が印加されて、転写ニップ部N内で被記録材Pに電荷が付与されて感光ドラム1上のトナー像が被記録材P側に順次静電転写される。

【0042】

【実施例】以下、実施例により本発明を具体的に説明するが、本発明はこれらの実施例のみに限定されるものではない。

【0043】実施例1

本例で使用した転写ローラ5は、φ6［mm］のFeの芯金5a上に、$5×10^{8}$［Ω］NBR系のイオン導電性ソリッドゴムからなる弾性層（中抵抗弾性層）5bを形成し、ローラ硬度65度（ASKER−C／総荷重1000g時）、外径をφ18［mm］としたソリッド（充填肉質）の導電性・弾性ローラである。

【0044】図4に本例の転写ローラ5の製造工程の概略フローを示す。まず、芯金上に弾性層としてNBR系イオン導電性ゴムをインジェクション成形、プレス成形、押し出し成形後芯金へ圧入等の成型方法で形成し、一次加硫を行う。本例ではインジェクション成形によってで弾性層を成形し、インジェクション成形型内で140℃30分間の加熱条件で一次加硫を行っている。

【0045】次に成型機から転写ローラを取り出し、一次加硫温度と同等、もしくはそれ以上の温度で二次加硫を行う。二次加硫はバッチ炉で行った。

【0046】表1及び表2に、二次加硫時の加熱条件と対感光ドラム汚染のテスト結果を示す。表1が加熱時間60分一定で加熱温度を種々変更した場合の結果、表2が温度150℃一定で加熱時間を種々変更した場合の結果である。対感光ドラム汚染テストは、二次加硫後に研磨・UV処理を行った転写ローラを感光ドラムに対して総圧1kgの加圧力で圧接固定し、温度50℃・湿度95％の過酷条件に設定した恒温槽に1週間放置した後に、該感光ドラムを用いて画像確認を行った結果である。上記過酷条件での放置テスト後にベタ黒画像の画出しを行い、画像上に転写ローラ弾性層内部からの物質の滲出による白スジが発生した場合をNGレベル（×）、白スジの発生が多少みられるものを（△）、全くみられないものを（○）として評価した。比較例として二次加硫を行わずに研磨・UV処理だけを行った転写ローラのテスト結果も比較例1として示す。

【0047】

【表1】

二次加硫温度（加硫時間60分固定）	無し（比較例1）	100	130	150	180	200
白スジレベル（実施例1）	×	△	○	○	○	○

【0048】

【表2】

二次加硫時間（加硫温度150℃固定）	無し（比較例1）	15	30	45	60	75
白スジレベル（実施例1）	×	×	△	○	○	○

【0049】表1及び表2から、二次加硫を行わない転写ローラ（比較例1）では、転写ローラからの滲出物質により感光ドラムが汚染され、ベタ黒に白いスジ上の画像乱れが発生するのに対し、二次加硫を行うと白スジの発生レベルが良くなる（画像上のスジが薄くなり、認識しづらくなる）、もしくは白スジの発生が防止されることがわかる。これは、二次加硫によって、感光ドラムを汚染する原因物質である一次加硫時の反応副生成物や、加硫剤の未反応残存成分、ゴムの未架橋低分子成分等が弾性層内部から除去されるためである。

【0050】また表1から、二次加硫時の加熱温度が130℃付近から感光ドラム汚染に対して効果が高くなる

ことがわかる。各種材料で転写ローラを成形し、同様のテストを行ったところ、一次加硫時の温度付近かそれ以上の温度で二次加硫を行うことで感光ドラム汚染に対して高い効果が現れることがわかった。また、表2より、二次加硫の時間については、加熱時間が長いほうが感光ドラム汚染に対する効果が高いことがわかる。

【0051】図5に、二次加硫時の加熱温度と転写ローラ抵抗値の関係を示す。二次加硫時間を60分の一定時間とし、加熱温度を種々変更して二次加硫を行った場合、二次加硫温度に応じて転写ローラの抵抗値が図5に示すように変化する。これは、二次加硫によって弾性層の表面が反応・劣化し表面抵抗が上昇するためである。二次加硫に伴う弾性層表面の劣化による表面抵抗の変化は一定ではなく、弾性層表面の劣化が進みすぎると、転写ローラの抵抗値の再現性が製造上低下する原因となる。このために、二次加硫による表面の劣化は極力少なくする必要がある。したがって、二次加硫の温度はこの表面層の劣化による転写ローラ弾性層の強度低下と、弾性層表面の劣化部分での抵抗値上昇による転写ローラ抵抗値の変化を考慮して決定する。

【0052】前述の説明でも示したように、二次加硫温度が130℃付近から対感光ドラム汚染防止の効果が現れる。しかし、二次加硫温度が200℃を超えると弾性層そのものの劣化が進みすぎるため転写ローラの抵抗値が変動しやすくなる。また、劣化が進むために通紙耐久により転写ローラ外径が磨耗して小さくなるという弊害がある。したがって、二次加硫温度は130℃～200℃の間に設定することが望ましい。

【0053】本例では、二次加硫による対感光ドラム汚染の効果、及びゴム劣化と転写ローラ抵抗値の上昇、量産性を考慮して、温度180℃60分で二次加硫を行った。

【0054】図6には研磨しろ量と転写ローラ抵抗値の関係を示す。

【0055】図6に示したように、二次加硫後の転写ローラの抵抗値は、研磨によって削り取られる研磨しろ量によっても変化する。これは二次加硫によって反応・劣化し抵抗値が上昇した弾性層の最表面を削り取るためで、二次加硫による転写ローラ抵抗値のばらつきを抑えるためには、研磨しろ量を肉厚0．1mm以上に設定することが望ましい。但し、研磨しろ量を大きくしすぎた場合、二次加硫後も弾性層のより中心部に近いところに残存している感光ドラム汚染物質が滲出し易くなるため、対感光ドラム汚染の観点からは研磨しろを肉厚0．4m以下とすることが望ましい。本例では研磨しろは約0．15mmとした。

【0056】最後に本発明では、弾性層成形・一次加硫・二次加硫・研磨全ての工程後に、仕上げとしてUV処理やオゾン被爆処理によって転写ローラ弾性層に表面処理を行う。この表面処理は、弾性層表面の凹凸を小さくし、研磨による表面性のばらつきを吸収して被記録材搬送性を安定させる効果がある。また、表面の粘着性が低下するために印字による紙粉の付着やトナーの付着を防止でき、表面に異物が付着することで転写ローラ表面の抵抗値が長期の使用によって変化する事に起因する画像の劣化を防止することができる。本例では表面処理として、波長が250nm近傍の紫外線ランプを3分間照射するUV処理を行った。

【0057】以上説明したように、弾性層としてソリッド状ゴムを用いた単層のソリッド転写ローラにおいて、一次加硫後に転写ローラを130～200℃で一次加硫時間よりも長い時間二次加硫する事で、一次加硫後に転写ローラ弾性層内に残留する滲出成分を除去することができ、対感光ドラム汚染を防止することが可能となる。また、二次加硫後に外径研磨を行うことで、高い外径精度で転写ローラを製造することができ、更にこの研磨によって二次加硫時に生じる弾性層表面の劣化部分をある程度除去して、転写ローラの抵抗値を安定化させることが可能となる。また、仕上げとしてUV処理・オゾン照射処理等の表面処理を行うことで被記録材搬送安定性に優れ、また表面に異物が付着しにくい転写ローラを得ることが可能となる。

【0058】実施例2

本実施例では、転写ローラを転写速回し系の画像形成装置で使用した例を示す。

【0059】画像形成装置の構成は、基本的には図1と同一であり、感光ドラムと転写ローラの駆動スピードだけが異なる。具体的には、本例での感光ドラムの外周速はプロセススピードに対して99％で駆動されており、感光ドラム・転写ローラの外径と両部材を駆動するギアのギア比から求められる転写ローラの計算上の外周速は、プロセススピードに対して102％とした。このように、転写ローラを感光ドラムに対して速回しし、被記録材を感光ドラムの外周速に対してスピード差を付けて搬送することで、感光ドラム上のトナーを掻き取る効果を持たせ、中抜けを防止している。本発明では、感光ドラムに対し転写ローラを＋0．5～6％の周速度の範囲で回転駆動させることができる。

【0060】このような転写速回し系の画像形成装置では、転写ニップ部で常に被記録材が感光ドラム・転写ローラとスリップしながら搬送されるため、被記録材の厚さや搬送路内の搬送抵抗、印字比率によって転写部での被記録材搬送速度が変化する。この搬送速度の変化は、転写ローラを感光ドラムに圧接する転写圧接力にともなって変化する傾向がある。紙種などの条件によって搬送スピードが遅くなった場合は、被記録材と感光ドラムとの周速差が小さくなって、感光ドラム上からトナー増を掻き取る効果が得られなくなり中抜けが発生する。また、逆に搬送スピードが速くなった場合は、転写時に画像が被記録材後端からはみ出してしまい、画像形成装置

内をトナーで汚してしまうという問題がある。

【0061】本例では、転写ローラとしてφ8［mm］の芯金上に押し出し成形したNBR系イオン導電性高分子を圧入して形成し、180℃60分の条件で二次加硫した後に研磨を行い外径をφ16［mm］、ゴム長を216［mm］とし、仕上げに表面処理として波長250nmの紫外線を3分間照射した、硬度60°（ASKER－C／1kg荷重時）の導電性ソリッドゴムローラを用いた。

【0062】表3に、上記転写ローラを用い、転写加圧力（総圧）を種々変化させた場合のニップ幅と被記録材搬送速度の変化量を示す。ここで示した被記録材搬送速度の変化量ΔXは、坪量60～150［g／m²］の紙種を用い、印字比率を4％～50％まで変化させて搬送した場合の副走査印字倍率の変化量である。副走査印字倍率は10mm間隔の横ラインデータを印字し、実際に＊被記録材上に印字された横ラインの間隔を測定し求めた。値はパーセント表示であり、副走査印字倍率100％をプロセススピード100％とした。また、ここで示した転写ニップ幅は、静止感光ドラム上にトナー、インク等を均一に塗布し、そこに転写ローラの両端に荷重を加えて感光ドラムに圧接し転写ローラ表面に付着したトナーまたはインクの幅の実測値である（長手方向中央部近傍のニップ幅で表す）。また官製葉書を使用した場合の中抜けの程度を評価した。評価基準は、以下の通りである。

○・・・文字の中抜けの発生無し
△・・・文字の中抜けの発生率が30～50％
×・・・文字の中抜けの発生率が50％超

【0063】
【表3】

総圧［kg］	0.8	1.0	1.3	1.5	2.0
ニップ幅［mm］	1.0	1.2	1.5	1.7	2.1
搬送速度変化量ΔX(%)	99.1 ～100.5	99.5 ～100.2	99.7 ～100.1	99.9 ～100.1	99.9 ～100.1
官製葉書中抜け	×	△	○	○	○

【0064】表3に示したように、転写加圧力（総圧）を大きくしニップ幅を広く取った場合、転写ニップ部での被記録材と感光ドラム、被記録材を転写ローラとの接触面積が増すために外部からの搬送抵抗や印字比率によって感光ドラム・転写ローラと被記録材とのスリップが起こりにくくなり、被記録材搬送速度の変化量ΔXが小さくなって搬送性が安定し、特にスリップの影響で搬送速度が遅くなりやすい官製葉書などの厚紙で、中抜けの発生が防止できる。

【0065】表4に本例で示した転写ローラを用い、転写加圧力を種々変化させた場合の転写ローラ・感光ドラム間の単位面積当たりの圧接力と、その圧接力をかけた※まま転写ローラと感光ドラムを40℃／95％環境に1週間放置した感光ドラムでの画像評価の結果を示す。比較例として、上記転写ローラと同一構成で、一次加硫後に二次加硫を行っていない転写ローラでのテスト結果を示す。ニップ白スジに対する評価基準は以下の通りである。

○・・・白スジの発生は全くみられない。
△・・・白スジの発生が若干みられる。
×・・・白スジの発生が著しい。

【0066】
【表4】

総圧［kg］	0.8	1.0	1.2	1.5	2.0
圧接力［g/mm²］	3.70	3.86	4.01	4.08	4.41
ニップ白スジ（実施例2）	○	○	○	○	△
ニップ白スジ（比較例2）	○	△	×	×	×

【0067】表4に示すように、本例で示した二次加硫を行った転写ローラ（実施例2）では、転写総圧1.5kgまでは感光ドラム上に転写ローラ内部からの含有成分の滲出による跡は認められず、ベタ黒画像の確認でも白スジは発生しなかった。

【0068】二次加硫をしない転写ローラ（比較例2）では、転写総圧1.2kg以上にすると、ベタ黒画像に転写ローラ内部物質の滲出による白スジが発生した。これは、単位面積当たりの圧接力が4.0g／mm²以上と高いために転写ローラが感光ドラムに対して強く押しつけられて、転写ローラからソリッドゴムに含まれるの低分子成分が滲出しやすくなったためであるが、二次加硫を行った転写ローラは転写総圧2.0kgまでほぼ滲出が防止できていることがわかる。

【0069】表3、表4より、従来の二次加硫を行わずにUV処理だけを行った転写ローラでは、搬送安定性・葉書での中抜けの防止と、対感光ドラム汚染防止を両立することが出来ないのに対し、本例で示した二次加硫を行った転写ローラではこれらの両立が容易にでき、駆動周差を持たせ高い転写圧接力をかけた条件でも、中抜け

や画像のはみ出しがなく、感光ドラムへの転写ローラ含有物の滲出による画像問題のない良好な画像を得ることが可能となった。

【0070】

【発明の効果】本発明によれば、導電性ソリッド転写ローラを用いるローラ転写方式の転写手段を有する画像形成装置において、

（1）転写ローラを研磨前に二次加硫処理をし、その後研磨を行い外径形状を所望の形状とした後に、ゴム部表面にＵＶ処理やオゾン処理等の表面処理を施すことで、転写ローラ表面に存在するゴムの低分子成分や、加硫剤等の添加物を二次加硫によって飛ばすと共に、表面処理によって滲出防止層を形成し、転写ローラ表面へのゴム内部物質の滲出を防止することが可能となった。

【0071】また、転写ローラゴム部表面を研磨後に表面処理して転写ローラ表面をＲｚ＝１０μｍ以下の平滑な面とすることで、研磨目の方向や表面粗さのばらつきによる被記録材搬送速度の変化を抑えると共に、ローラ表面への紙粉やトナーの付着を防止して、長期に亘り良好な画像を維持可能となった。

【0072】（２）転写ローラを研磨前に二次加硫処理をし、その後研磨を行い外径形状を所望の形状とした後に、ゴム部表面にＵＶ処理やオゾン処理等の表面処理を施すことで、転写ローラ表面に存在するゴムの低分子成分や、加硫剤等の添加物を二次加硫によって飛ばし、高い転写圧接力をかけても転写ローラ内部から感光ドラム＊に対して汚染物質が滲出するのを防止し、転写ニップ部での被記録材搬送安定性と対感光ドラム汚染防止の両立が可能となった。

【図面の簡単な説明】

【図１】本発明を適用した画像形成装置の略断面図である。

【図２】転写ローラ部分の一端側の拡大側面模式図である。

【図３】転写ローラの途中部分省略正面模式図である。

【図４】本発明の転写ローラ製造工程の概略を示すフロー図である。

【図５】二次加硫温度と転写ローラ抵抗値の関係を示すグラフである。

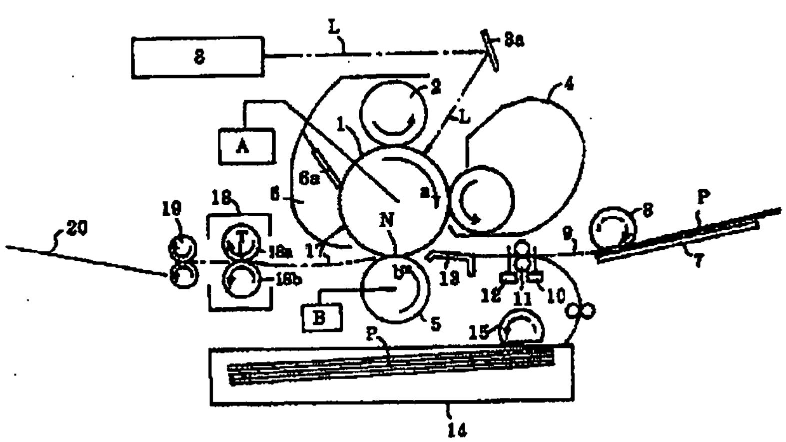
【図６】転写ローラの研磨しろ量と抵抗値の関係を示すグラフである。

【図７】転写ローラの抵抗値測定方法の概略を示す図である。

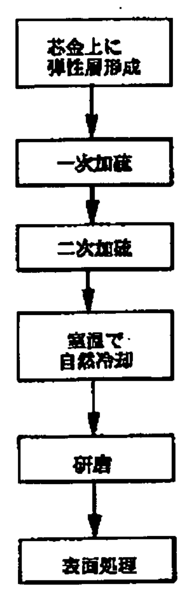
【符号の説明】

１：感光ドラム
５：転写ローラ
５ａ：転写ローラ芯金
５ｂ：弾性層
５ｃ：転写軸受け
５ｄ：転写加圧バネ
Ｎ：転写ニップ
Ｐ：被記録材

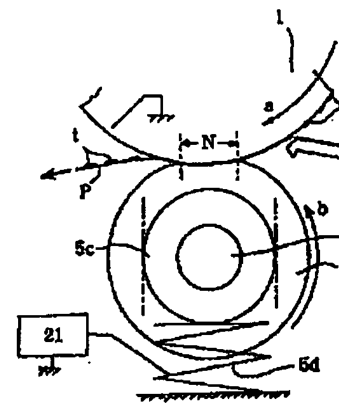
【図１】



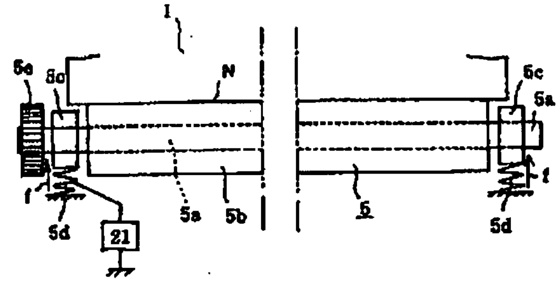
【図４】



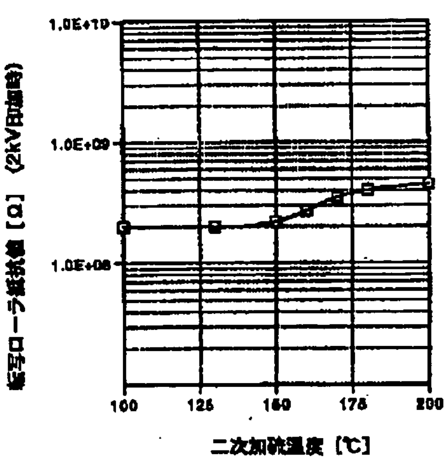
【図2】


1
a
t
N
c
P
13
b
5c
5a
5b
5
21
5d

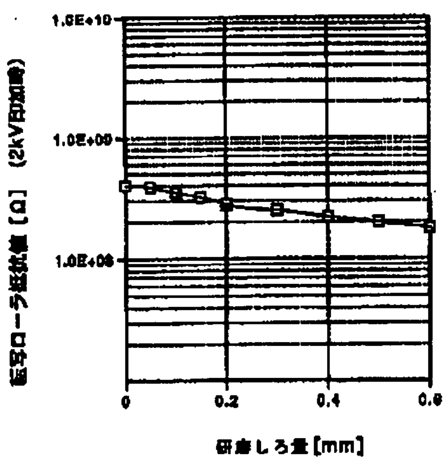
【図3】


1
N
5e
5c
5a
5b
5
f
5d
21

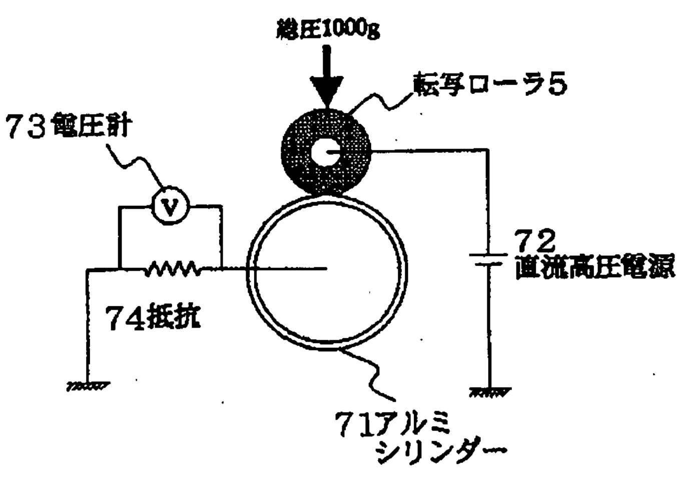
【図5】


転写ローラ抵抗値［Ω］（2kV印加時）
1.0E+10
1.0E+09
1.0E+08
100
125
150
175
200
二次加硫温度［℃］

【図6】


転写ローラ抵抗値［Ω］（2kV印加時）
1.0E+10
1.0E+09
1.0E+08
0
0.2
0.4
0.6
研磨しろ量［mm］

【図7】


総圧1000g
転写ローラ5
73電圧計
V
72
直流高圧電源
74抵抗
71アルミ
シリンダー